

SPECIAL FORECASTS AND WARNINGS. WEATHER AND CROPS.

WEATHER WARNINGS, NOVEMBER, 1919.

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STORM WARNINGS.

The storm of November 29 and 30.—This storm was the only great storm of the month, and, measured by pressure and wind velocity conditions, it was perhaps the greatest Great Lake storm since November, 1913. It followed the abnormal development of a disturbance over the Southern Plateau at a time when marked high pressure prevailed over the entire northern and central sections of the country from the Rocky Mountains to the Atlantic Ocean, and was first noticed on the morning of the 28th as a very moderate depression over southeastern Texas. By the evening of that day the depression had moved northward to southwestern Arkansas, and pressure had fallen decidedly over the entire interior of the country east of the Rocky Mountains, and at 9:40 p. m. advisory warnings for Lake Michigan were issued. Pressure continued to fall rapidly during the night and by the morning of the 29th the disturbance had attained the proportions of a great storm, being central at the time over northern Illinois with a lowest barometer reading of 29.30 inches. Winds had increased considerably to the eastward, but not to the northward. Storm warnings were at once ordered at all Lake stations and strong winds and gales forecast. Northwest warnings were ordered for Lakes Superior and Michigan, and southwest warnings for Lakes Huron, Erie, and Ontario, to be changed to northwest at sunset on Lake Huron. Southwest warnings were also ordered displayed at 12:00 noon along the Atlantic coast from Eastport, Me., to Delaware Breakwater, Del., and southeast warnings southward to Jacksonville, Fla. Small-craft warnings were ordered displayed along the east coast of the Gulf of Mexico for fresh to moderately strong southwest to west winds.

Special observation taken at 1:00 p. m. showed that the storm was still rapidly increasing in intensity, and at 3:00 p. m. the following warning was issued to all Lake stations:

"Storm centered 1:00 p. m. over southern Wisconsin, greatly increased intensity. Dangerous winds all Lakes tonight and Sunday shifting on upper Lakes, becoming northwest; generally south and southwest on lower Lakes to-night, shifting to west and northwest Sunday. Snow and much colder. Caution all vessels to observe every precaution for safety."

The storm was then central over southern Wisconsin with barometer readings slightly below 29 inches, and with increasing winds, while to the southward a quick recovery in pressure had set in attended by clearing weather and strong winds and gales, the strong winds extending down to the Gulf coast. By 8:00 p. m. the storm center had passed to the northeastward of Lake Superior (pressure at Sault Ste Marie 28.58 inches), and the barometer was rising as far north as the southern limits of Lake Michigan. On the morning of the 30th the storm center was probably some hundreds of miles east of James Bay (barometer at Father Point, Canada, 29.06 inches, with fresh winds from the southwest), and the warnings on the Atlantic coast were ordered changed

to northwest. The northwest warnings were also continued until sunset on the upper Lakes. By the morning of December 1 the storm had disappeared beyond the field of observation.

The winds during this storm blew with force ranging from fresh gales to hurricanes. The greatest hourly velocities attained on the Lakes were 72 miles at Port Huron, Mich.; 84 miles at Detroit, Mich.; 80 miles at Toledo, Ohio, and Buffalo, N. Y.; but notwithstanding these extreme velocities, there was not a single marine casualty—probably a hitherto unprecedented occurrence for a storm of such great magnitude and intensity. There was, however, considerable damage done on shore and over interior districts southward through the Ohio valley and Tennessee. Along the Atlantic coast the winds were not so violent, New York City reporting a maximum velocity of 64 miles an hour from the northwest.

Other warnings.—Special 1 p. m. observation on November 3 indicated falling pressure over the Great Lakes, with a rapid rise to northwest, and at 3 p. m. northwest-storm warnings were ordered for Lake Michigan and for central and western Lake Superior. Pressure continued to fall over the Lakes, and on the morning of the 4th the warnings were extended over eastern Lake Superior and Lake Huron. Southwest warnings were also ordered for Lake Erie and at 3:30 p. m. for Lake Ontario. Strong winds occurred generally as forecast. By 8 p. m. of the 4th the principal center of disturbance was over Ontario, with a secondary one over eastern Maryland, and at 9:30 p. m. northeast storm warnings were ordered along the New England coast from Point Judith, R. I., to Eastport, Me. By the morning of the 5th there was a single severe disturbance just off the Massachusetts coast, with gales that extended westward to the northern New Jersey coast. The storm continued northeastward, and at 9:30 p. m. the warnings on the Maine coast were changed to northwest. Strong winds occurred on the 5th, as forecast, and also persisted over the ocean to the southward. Unusually high tides prevailed during the passage of this storm, and for a day or two after, causing great damage along the coast from New York northward almost to Maine. The damage was estimated at more than \$1,000,000.

On the morning of the 9th a disturbance from the north Pacific Ocean was central over western Texas and small-craft warnings for the fresh to moderately strong easterly winds that followed were ordered along the Gulf coast from Bay St. Louis, Miss., to Carrabelle, Fla. By 8 p. m. the storm center was over southeastern Nebraska, with increased intensity, and at 10 p. m. southeast-storm warnings were ordered on Lakes Superior and Michigan, and on Lake Huron from Saginaw, Mich., northward. By the morning of the 10th the storm had developed into a severe one, with its center over southern Minnesota, and with strong high pressure over the Middle Atlantic States and New England, and the southeast warnings were extended over the entire Great Lake area, south and southwest gales being forecast. At 1 p. m. the storm center was over extreme western Lake Superior, and at 3 p. m. orders were issued to change all warnings

to southwest at sunset, except along Lake Superior west of Houghton, where northwest warnings were ordered. General gales occurred as forecast, the storm continuing northeastward toward James Bay.

On the morning of the 17th there was a disturbance off the southeast coast of Florida, and advisory warnings of possibly increasing winds were issued. Conditions became somewhat more pronounced by 8 p. m., and at 9:30 p. m. northwest storm warnings were ordered from Miami to Jacksonville, Fla., and northeast warnings to the northward as far as Georgetown, S. C. At the same time a disturbance from the Canadian northwest was central north of Georgian Bay, with an apparent tendency toward increased development, and at 10 p. m. southwest-storm warnings were ordered from Cleveland, Ohio, to Oswego, N. Y., and strong winds occurred on the lower lakes on the 18th and extended northward over Lake Huron. The South Atlantic disturbance continued to develop, and at 11 a. m. of the 18th the northeast warnings were extended northward to Fort Monroe, Va. By 8 p. m. there was a secondary disturbance over southern New England and northwest warnings were ordered from Sandy Hook, N. J., to Provincetown, Mass. Reports received by radio indicated the occurrence of gales a short distance off the South Atlantic coast, but no strong winds were reported from coast stations. Along the northern coast strong winds and gales occurred.

As the low pressure still persisted off the Atlantic coast northwest-storm warnings were ordered at 3 p. m. November 19 from Hatteras, N. C., to Atlantic City, N. J., to be lowered at 8 a. m. of the 20th, and at 7 p. m. the northwest warnings from Sandy Hook to Provincetown were ordered continued for another day. These warnings were fully verified.

From the 21st to the 24th, inclusive, a disturbance moved eastward over Canada and the northern tier of States with increased intensity, but with its center north of latitude 48°, and no warnings were ordered for the strong winds of short duration that occurred during the 22d over Lake Erie and southern Lake Huron. At 10 p. m. of that date northwest warnings were ordered for Lake Ontario and southwest warnings along the Atlantic coast from Delaware Breakwater to Eastport, Me., the storm center at that time being over northern Ontario. These warnings were not verified, only fresh to moderately strong winds occurring.

On the evening of the 24th another northwestern disturbance was central over eastern Kansas in moderate form, with a cold high area developing rapidly to northward, and at 10:00 p. m. northeast-storm warnings were ordered on Lake Superior and northern Lake Michigan, snow, with strong northeast to north winds being forecast, to be followed by a cold wave on the night of the 25th. On the morning of the 25th the center of the disturbance was over southern Michigan, with about the same intensity, but the cold high area to the northwestward had increased decidedly in magnitude and intensity, and northwest warnings were accordingly ordered for southern Lake Michigan and Lakes Huron and Erie, forecasts of snow with a cold wave being included in the warning. At 3 p. m. the warnings on Lake Superior and northern Lake Michigan were changed to northwest. The storm did not develop further, and the warnings for the lower Lakes were not verified, although they were fully justified on the upper Lakes. This disturbance extended in trough shape from northeast to southwest, and on the morning of November 26, a secondary development of the southwestern section was central over eastern Kentucky, with continued cold and still higher pressure to

the northwestward, and at 3:00 p. m. northeast warnings were ordered on the lower Lakes, strong northeast to north wind, with snow, being forecast. These warnings were verified for the most part.

Marine casualties.—Some casualties occurred along the southern New England coast during the high winds of November 5 and 6, but there were none on the Great Lakes, except on Superior, where, unfortunately, several major disasters occurred, with the loss of a considerable number of lives.

Panama northers.—A warning of increasing northeast winds becoming strong by November 14 or 15, was sent to the Panama Canal Zone on the 13th. Strong north winds occurred for several days, but, contrary to previous experience, they began from 24 to 36 hours earlier than had been forecast. The maximum wind velocities reported by Mr. R. Z. Kirkpatrick, chief hydrographer of the Canal Zone were 25 miles an hour from northeast at Colon on November 12 and 50 miles an hour from north at Cape Mala on the 13th. The type of pressure distribution prevailing when the warning was issued was one of generally strong and high pressure over the United States with the crest over the west Gulf States and low pressure over the Caribbean Sea and the Middle Atlantic Ocean.

COLD WAVES AND FROSTS.

Although the high area on the second day of November, following the disturbance of the few previous days was of moderate character only, the accompanying temperatures to westward were rather low, and warnings of frost for the morning of November 3 were issued for the lower Lake region, the upper Ohio Valley, Tennessee, the higher districts of the Carolinas, the middle Atlantic States and southern New England. These frosts occurred generally as forecast, except in the Carolinas. There were no other frosts of consequence for some time, except the killing frost of the morning of the 5th over the Ohio Valley, for which no warnings had been issued, although much colder weather had been forecast.

The first cold-wave warning of the month was issued on the evening of the 11th and covered Michigan and Indiana. At the time a moderate disturbance was over southeast Kansas moving northeast, with a cold and extensive high area covering the northwest. On the morning of the 12th, with the center of disturbance over upper Michigan, the cold-wave warnings were extended through the western upper Lake region, the Ohio Valley, Tennessee, and the lower Mississippi Valley. A moderate cold wave followed on the morning of the 13th, except in eastern lower Michigan and the lower Mississippi Valley, where the fall in temperature was not sufficient to justify a cold-wave warning, although the temperatures were quite low for the season. High pressure and low temperatures prevailed over the interior of the country, and cold-wave, freezing-temperature and frost-warnings were issued quite generally for the middle and south Atlantic and the east Gulf States. These warnings were also verified on the morning of the 14th, except along the south Atlantic coast and over northern Florida, where cloudy weather continued. Frost-warnings were again issued for South Carolina, northern Florida, and the east Gulf States, and were verified on the morning of the 15th except in northeastern Florida.

Nothing further developed until the evening of the 24th when high and rising pressure and low and falling temperatures prevailed over the Canadian Northwest, and a disturbance of fair proportions was over the lower Mis-

souri Valley moving eastward. Cold-wave warnings were issued at 10 p. m. for Michigan, and extended on the following morning over the western lower Lake region, the Ohio Valley, Western Tennessee and extreme northern Mississippi. A secondary disturbance developed during the night of the 24th-25th over the lower Arkansas Valley, while the northern disturbance moved slowly, and pressure over the Middle Atlantic States rose considerably. The fall in temperature was consequently interrupted, and the cold-wave warnings failed generally of verification.

By the evening of November 26, pressure was falling over the Atlantic Ocean, was low over the Atlantic States with high temperatures and still abnormally high over the northwest. Cold-wave warnings were accordingly ordered for the Middle and South Atlantic States, except Florida. It happened that an offshoot from the northwestern high area moved rapidly eastward, causing northeast winds, with generally cloudy weather, and there were no cold waves.

Following the great storm of November 29, cold-wave warnings were ordered for the Lake region, the Ohio and Mississippi Valleys, and the Atlantic States as far south as Georgia. These warnings were almost entirely verified by the occurrence of a general cold wave over the districts covered by the warnings.

WARNINGS FROM OTHER DISTRICTS.

Chicago (Ill.) Forecast District.—The month was marked by rapid storm movement over the district during the first and third decades, with unsettled conditions and more or less precipitation and variable temperature, while in the second decade the conditions were much different, as a rule, moderate temperature and fair weather, in fact the so-called Indian summer type then prevailing, especially in the eastern and southern portions of the forecast district.

The mean temperature for the entire month was far below the normal in the Northwest, and generally below the normal in all portions of the district, except the Lake Michigan region and middle Mississippi Valley. The lowest temperature recorded was -20° at Williston, N. Dak., and Lander, Wyo., and zero temperatures extended well into the central Great Plains.

At the beginning of the month all crops had fully matured and had been harvested in practically all portions of the district, except southern Illinois and eastern and southern Missouri and, as a consequence, frost-warnings were necessary only in the last-named sections.

On the 1st, advices for frost were sent to these places in advance of a cold wave pushing eastward, and heavy-to-killing frosts were reported on the morning of the 2d, thus terminating the frost-warning season for 1919.

The first cold-wave warning of the month was issued on the 3d in advance of a cold wave which appeared in Alberta on the morning of that day, advices being sent to northern and western Minnesota, Kansas, Illinois, Missouri, and Wisconsin, and the greater portion of Iowa, and by the morning of the 4th the lowest temperatures noted this season were then reported from the Plain States eastward over the upper Mississippi Valley. The cold wave, however, was followed by rapid recovery throughout the middle western sections. By the morning of the 6th another cold wave overspread the northern Plains States, and, although colder weather was predicted for the area affected, the marked fall in temperature was not anticipated. Warnings, moreover, were issued on the morning of the 6th to the districts

to the south and east as far as the Mississippi River in anticipation of the eastward movement of this wave; but because of the passage of the high-pressure area far to the north, with accompanying unsettled conditions and northeast winds, the cold wave was rapidly dissipated.

On the morning of the 7th a depression was centered over the middle plateau, and, as it promised to develop in its movement southeastward and be followed by winds shifting to northerly and by colder weather, precautionary advices were sent to live-stock interests in Wyoming, South Dakota, Nebraska, and Kansas. At the same time cold-wave warnings were issued to stations in northern and central portions of the Great Plains. By the morning of the 9th the center of the disturbance had reached Texas. It then changed its course and moved directly northeastward, accompanied by shifting gales and colder weather, with snow on its western side. By the 11th another disturbance had appeared in the plateau which advanced rapidly eastward and was followed by a cold wave over the greater portion of this forecast district. Cold-wave warnings were issued to most stations well in advance of the fall in temperature, and at the same time special advices were sent to stock interests in Wyoming, Nebraska, and Kansas of snow and strong northerly winds, as well as cold weather. This wave proved general and unusually severe for the season of the year.

Then ensued a period of comparatively settled weather, and it was not until the morning of the 24th that another cold wave appeared in the British northwest. This rapidly forced its way southward over the Great Plains and upper Mississippi Valley, with a decided fall in temperature and rather strong northerly winds and some snow; but in the sections east and south the severe conditions were not felt, as the center of the high-pressure area remained far to the north, with resulting northeast winds and cloudy weather. Cold-wave warnings and advices to stock interests were, however, telegraphed to the sections affected well in advance of the storm.

A disturbance, centered in the west Gulf region on the 28th, moved directly northeastward over the upper Lakes by the 29th, and, as at the same time a cold wave had appeared in the British Northwest, warnings were issued to live-stock interests in the Plains States on the morning of the 28th, and cold-wave warnings on the 29th to points in the upper Mississippi Valley eastward over Illinois and Wisconsin. As the temperature had risen considerably in the Middle States in advance of the disturbance, the ensuing falls in temperature were quite marked, and the accompanying gales were severe.

The month closed with unusually low temperatures over the entire forecast district.—H. J. Cox.

New Orleans (La.) Forecast District.—Storm warnings for strong northerly winds were ordered displayed on the east coast of Texas on the 12th and 27th, because of areas of high barometer moving southward. The winds attending these highs, however, were not very strong on the coast, although moderate gales have occurred previously with maps of similar barometric gradient. No general storm without warnings occurred.

Small-craft warnings were displayed on the Louisiana and Texas coasts on the 9th and on the Louisiana coast on the 29th, and were justified.

Cold waves of unusual severity for the season occurred in the northwestern portion of the district but did not reach the coast sections.

On the p. m. map of the 3d, a trough of low pressure was over the Mississippi Valley and the West Gulf

States and a moderate area of high pressure and colder weather overspread the eastern slope of the northern Rocky Mountain Region. On these conditions, cold-wave warnings were ordered for the Texas Panhandle, Oklahoma, and Bentonville, Ark. The temperature dropped sharply on the 4th but was not low enough for a cold wave, the change to colder being neutralized by an area of low pressure from the North Pacific coast, which was central over southeastern Wyoming on the morning of the 5th.

On the morning of the 8th a well-defined area of low pressure was central over northeastern New Mexico and an extensive high area was over western Canada. Cold-wave warnings were ordered for the same area as on the 3d and were extended, after the receipt of special observations, over northwestern Texas as far east as Dallas. A cold wave occurred in the extreme northwestern portion of the district, but before it could extend farther, the southwestern low, which at first moved southward, changed its course and moved northeastward and the high pressure diminished rapidly.

During the afternoon of the 11th an area of high pressure and colder weather was moving southeastward from western Canada and Montana, preceded by a shallow trough of low pressure. Cold-wave warnings were ordered, on the p. m. map, for Oklahoma, Arkansas, west Texas, and the northern portion of east Texas, and were extended the next morning over northern Louisiana and the remainder of Texas except the immediate coast. These warnings were verified.

The p. m. map of the 24th showed an area of high pressure moving southward from the interior provinces of western Canada, preceded by low pressure over the upper Mississippi Valley and the southern Plains States. Cold-wave warnings were issued for Oklahoma and the Texas Panhandle. The warnings were extended on the morning of the 25th over Arkansas, and at night over northern Louisiana and the northern portion of east Texas. Low pressure developed over the southern Rocky Mountain Plateau and prevented the cold wave from reaching the southern and eastern portions of the district, although a cold wave occurred in Oklahoma and northwestern Texas. As the cold wave still threatened on the morning of the 26th, midday special observations were obtained and cold-wave warnings were issued for the entire district except southern Louisiana and the southeastern portion of east Texas, but the warnings were extended over the southeastern portion of east Texas on the night of the 26th and southern Louisiana on the morning of the 27th. The warning issued in the afternoon of the 26th stated that the cold wave would be severe in Oklahoma and northwestern Texas, with strong northerly winds. Conditions occurred as forecast in the northwestern portion of the district, but the cold wave reached only the interior portions of Texas and did not extend over Arkansas and Louisiana. The southwestern low after being forced southwestward to the southern California coast, moved eastward, preceded by a rapid fall in pressure over the area dominated by the high, preventing the cold wave from extending farther.

Live-stock interests were advised of cold-wave warnings and severe conditions.

Frost warnings were issued for the northern portion of the district early in the month but by the close of the month were being issued only for the southern portions of Louisiana and east Texas. Warnings of freezing temperature were issued when indicated. Most of the

warnings of frost or freezing temperature were verified. Frost warnings were issued on the 1st, 4th, 10th, 12th, 13th, 14th, 29th, and 30th.—*R. A. Dyke.*

Denver (Colo.) Forecast District.—The snowfall was unusually heavy for November over the northern half of the district, and heavy rains occurred in Arizona during the latter part of the month, causing remarkably high water in the Gila River. Several cold waves occurred; they formed quickly and developed intense cold along the middle eastern Rocky Mountain slope, while in southwestern Colorado and adjacent region the coming of the cold was belated.

Among the important warnings, which were fully verified as a rule, were the live-stock warnings issued on the morning of the 8th for eastern Colorado, the cold-wave warnings issued on the morning of the 11th for eastern Colorado, and the cold-wave warnings of the 26th for south and west Colorado and extreme eastern New Mexico, extended on the morning of the 27th over southwest Colorado, northwest New Mexico, north-central and northeast Arizona, and southeast Utah. On the morning of the 28th a warning was issued for freezing temperature in western and southern Arizona. This warning was fully verified. Several local cold waves occurred for which the forecast was confined to "colder" without the designation of "cold wave."—*Frederick H. Brandenburg.*

San Francisco (Calif.) Forecast District.—The pressure distribution prevailing over this district during November was unfavorable for precipitation except in western Washington. The pressure continued high, or comparatively high, over California and the Plateau region during the greater portion of the month, and the storms moving southeast from the north Pacific passed inland through northern British Columbia with an occasional depression moving southeastward over Alberta. This type of pressure distribution is not uncommon in September and October, but seldom prevails in November. It is one that causes fair and pleasant weather with warm days and cool nights in California and the Plateau region.

During the first week the storm movement was sufficiently far south to give precipitation over the northern portion of this district, but from the 8th to the 28th, the storm passage was farther north and very little precipitation occurred except in western Washington. On the 25th an area of low pressure developed over the southern Plateau, increased rapidly in intensity, gave rain in southern California on the 26th and 27th, and, in conjunction with a storm appearing over British Columbia on the 28th, caused light but general precipitation in other sections of this district until the close of the month.

Frosts occurred frequently in the interior of California, but were not of sufficient severity to cause material damage. Frost warnings were issued for the interior of California on the 9th to 14th, inclusive, and on the 27th and 28th, and in southern California on the 29th and 30th.

Storm warnings were ordered at the mouth of the Columbia River and Washington stations on the 1st, 3d, 6th, and 14th, from San Francisco to Eureka on the 26th, and from Port Harford to San Diego on the 27th. On the 26th and 27th fresh to whole northerly gales prevailed over northern California, knocking some oranges off the trees and wrecking a few small fishing boats in Monterey Bay. The winds during this storm attained a very high velocity, but the timely warnings undoubtedly prevented serious damage to shipping.—*G. H. Willson.*